No. XXXVII.

General Principles and Conſtruction of a Sub-marine Veſſel, communicated by D. Buſhnell of Connecticut, the inventor, in a letter of October, 1787, to THOMAS JEFFERSON *then Miniſter Plenipotentiary of the United States at Paris.*

Read June 8, 1798.

THE external ſhape of the ſub-marine veſſel bore ſome reſemblance to two upper tortoiſe ſhells of equal ſize, joined together; the place of entrance into the veſſel being repreſented by the opening made by the ſwell of the ſhells, at the head of the animal. The inſide was capable of containing the operator, and air, ſufficient to ſupport him thirty minutes without receiving freſh air. At the bottom oppoſite to the entrance was fixed a quantity of lead for ballaſt. At one edge which was directly before the operator, who ſat upright, was an oar for rowing forward or backward. At the other edge, was a rudder for ſteering. An aperture, at the bottom, with its valve, was deſigned to admit water, for the purpoſe of deſcending; and two braſs forcing-pumps ſerved to eject the water within, when neceſſary for aſcending. At the top, there was likewiſe an oar, for aſcending or deſcending, or continuing at any particular depth—A water-gauge or barometer, determined the depth of deſcent, a compaſs directed the courſe, and a ventilator within, ſupplied the veſſel with freſh air, when on the ſurface.

The entrance into the veſſel was elliptical, and ſo ſmall as barely to admit a perſon. This entrance was ſurrounded with a broad elliptical iron band, the lower edge of which was let into the wood of which the body of the veſſel was made, in ſuch a manner, as to give its utmoſt ſupport to the body of the veſſel againſt the preſſure of the water. Above the upper edge of this iron band, there was a braſs crown, or cover, reſembling a hat with its crown and brim, which

which ſhut water tight upon the iron band: the crown was hung to the iron band with hinges ſo as to turn over ſidewiſe, when opened. To make it perfectly ſecure when ſhut, it might be ſcrewed down upon the band by the operator, or by a perſon without.

There were in the braſs crown, three round doors, one directly in front, and one on each ſide, large enough to put the hand through—when open they admitted freſh air; their ſhutters were ground perfectly tight into their places with emery, hung with hinges and ſecured in their places when ſhut. There were likewiſe ſeveral ſmall glaſs windows in the crown, for looking through, and for admitting light in the day time, with covers to ſecure them. There were two air pipes in the crown. A ventilator within drew freſh air through one of the air pipes, and diſcharged it into the lower part of the veſſel; the freſh air introduced by the ventilator, expelled the impure light air through the other air pipe. Both air pipes were ſo conſtructed, that they ſhut themſelves whenever the water roſe near their tops, ſo that no water could enter through them, and opened themſelves immediately after they roſe above the water.

The veſſel was chiefly ballaſted with lead fixed to its bottom; when this was not ſufficient, a quantity was placed within, more or leſs, according to the weight of the operator; its ballaſt made it ſo ſtiff, that there was no danger of overſetting. The veſſel with all its appendages, and the operator, was of ſufficient weight to ſettle it very low in the water. About two hundred pounds of the lead, at the bottom, for ballaſt, would be let down forty or fifty feet below the veſſel; this enabled the operator to riſe inſtantly to the ſurface of the water, in caſe of accident.

When the operator would deſcend, he placed his foot upon the top of a braſs valve, depreſſing it, by which he opened a large aperture in the bottom of the veſſel, through which the water entered at his pleaſure; when he had admitted

mitted a ſufficient quantity, he deſcended very gradually; if he admitted too much, he ejected as much as was neceſſary to obtain an equilibrium, by the two braſs forcing pumps, which were placed at each hand. Whenever the veſſel leaked, or he would aſcend to the ſurface, he alſo made uſe of theſe forcing pumps. When the ſkilful operator had obtained an equilibrium, he could row upward, or downward, or continue at any particular depth, with an oar, placed near the top of the veſſel, formed upon the principle of the ſcrew, the axis of the oar entering the veſſel; by turning the oar one way he raiſed the veſſel, by turning it the other way he depreſſed it.

A glaſs tube eighteen inches long, and one inch in diameter, ſtanding upright, its upper end cloſed, and its lower end, which was open, ſcrewed into a braſs pipe, through which the external water had a paſſage into the glaſs tube, ſerved as a water-gauge or barometer. There was a piece of cork with phoſphorus on it, put into the water-gauge. When the veſſel deſcended the water roſe in the water-gauge, condenſing the air within, and bearing the cork, with its phoſphorus, on its ſurface. By the light of the phoſphorus, the aſcent of the water in the gauge was rendered viſible, and the depth of the veſſel under water aſcertained by a graduated line.

An oar, formed upon the principle of the ſcrew, was fixed in the forepart of the veſſel; its axis entered the veſſel, and being turned one way, rowed the veſſel forward, but being turned the other way rowed it backward; it was made to be turned by the hand or foot.

A rudder, hung to the hinder part of the veſſel, commanded it with the greateſt eaſe. The rudder was made very elaſtic, and might be uſed for rowing forward. Its tiller was within the veſſel, at the operator's right hand, fixed, at a right angle, on an iron rod, which paſſed through the ſide of the veſſel; the rod had a crank on its

outſide end, which commanded the rudder, by means of a rod extending from the end of the crank to a kind of tiller, fixed upon the left hand of the rudder. Raiſing and depreſſing the firſt mentioned tiller turned the rudder as the caſe required.

A compaſs marked with phoſphorus directed the courſe, both above and under the water; and a line and lead ſounded the depth when neceſſary.

The internal ſhape of the veſſel, in every poſſible ſection of it, verged towards an ellipſis, as near as the deſign would allow, but every horizontal ſection, although elliptical, yet as near to a circle, as could be admitted. The body of the veſſel was made exceedingly ſtrong; and to ſtrengthen it as much as poſſible, a firm piece of wood was framed, parallel to the conjugate diameter, to prevent the ſides from yielding to the great preſſure of the incumbent water, in a deep immerſion. This piece of wood was alſo a ſeat for the operator.

Every opening was well ſecured. The pumps had two ſets of valves. The aperture at the bottom, for admitting water, was covered with a plate, perforated full of holes to receive the water, and prevent any thing from choaking the paſſage, or ſtopping the valve from ſhutting. The braſs valve might likewiſe be forced into its place with a ſcrew, if neceſſary. The air pipes had a kind of hollow ſphere, fixed round the top of each, to ſecure the air-pipe valves from injury: theſe hollow ſpheres were perforated full of holes for the paſſage of the air through the pipes: within the air-pipes were ſhutters to ſecure them, ſhould any accident happen to the pipes, or the valves on their tops.

Wherever the external apparatus paſſed through the body of the veſſel, the joints were round, and formed by braſs pipes, which were driven into the wood of the veſſel, the holes through the pipes were very exactly made, and the iron rods, which paſſed through them, were turned in

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a lathe to fit them; the joints were alſo kept full of oil, to prevent ruſt and leaking. Particular attention was given to bring every part, neceſſary for performing the operations, both within and without the veſſel, before the operator, and as conveniently as could be deviſed; ſo that every thing might be found in the dark, except the water-gauge and the compaſs, which were viſible by the light of the phoſphorus, and nothing required the operator to turn to the right hand, or to the left, to perform any thing neceſſary.

No. 2.

Deſcription of a magazine and its appendages, deſigned to be conveyed by the ſub-marine veſſel to the bottom of a ſhip.

In the forepart of the brim of the crown of the ſub-marine veſſel, was a ſocket, and an iron tube, paſſing through the ſocket; the tube ſtood upright, and could ſlide up and down in the ſocket, ſix inches: at the top of the tube, was a wood-ſcrew (A) fixed by means of a rod, which paſſed through the tube, and ſcrewed the wood-ſcrew faſt upon the top of the tube: by puſhing the wood-ſcrew up againſt the bottom of a ſhip, and turning it at the ſame time, it would enter the planks; driving would alſo anſwer the ſame purpoſe; when the wood-ſcrew was firmly fixed, it could be caſt off by unſcrewing the rod, which faſtened it upon the top of the tube.

Behind the ſub-marine veſſel, was a place, above the rudder, for carrying a large powder magazine, this was made of two pieces of oak timber, large enough when hollowed out to contain one hundred and fifty pounds of powder, with the apparatus uſed in firing it, and was ſecured in its place by a ſcrew, turned by the operator. A ſtrong piece of rope extended from the magazine to the wood-ſcrew (A) above mentioned, and was faſtened to both.

When the wood-ſcrew was fixed, and to be caſt off from its tube, the magazine was to be caſt off likewiſe by unſcrewing it, leaving it hanging to the wood-ſcrew; it was lighter than the water, that it might riſe up againſt the object, to which the wood-ſcrew and itſelf were faſtened.

Within the magazine was an apparatus, conſtructed to run any propoſed length of time, under twelve hours; when it had run out its time, it unpinioned a ſtrong lock reſembling a gun lock, which gave fire to the powder. This apparatus was ſo pinioned, that it could not poſſibly move, till, by caſting off the magazine from the veſſel, it was ſet in motion.

The ſkilful operator could ſwim ſo low on the ſurface of the water, as to approach very near a ſhip, in the night, without fear of being diſcovered, and might, if he choſe, approach the ſtem or ſtern above water, with very little danger. He could ſink very quickly, keep at any depth he pleaſed, and row a great diſtance in any direction he deſired, without coming to the ſurface, and when he roſe to the ſurface, he could ſoon obtain a freſh ſupply of air, when, if neceſſary, he might deſcend again, and purſue his courſe.

No. 3.

Experiments made to prove the nature and uſe of a ſub-marine veſſel.

The firſt experiment I made, was with about two ounces of gun powder, which I exploded 4 feet under water, to prove to ſome of the firſt perſonages in Connecticut, that powder would take fire under water.

The ſecond experiment was made with two pounds of powder, incloſed in a wooden bottle, and fixed under a hogſhead, with a two inch oak plank between the hogſhead and

and the powder; the hogſhead was loaded with ſtones as deep as it could ſwim; a wooden pipe deſcending through the lower head of the hogſhead, and through the plank, into the powder contained in the bottle, was primed with powder. A match put to the priming, exploded the powder, which produced a very great effect, rending the plank into pieces; demoliſhing the hogſhead; and caſting the ſtones and the ruins of the hogſhead, with a body of water, many feet into the air, to the aſtoniſhment of the ſpectators. This experiment was likewiſe made for the ſatisfaction of the gentlemen above mentioned.

I afterwards made many experiments of a ſimilar nature, ſome of them with large quantities of powder; they all produced very violent exploſions, much more than ſufficient for any purpoſe I had in view.

In the firſt eſſays with the ſub-marine veſſel, I took care to prove its ſtrength to ſuſtain the great preſſure of the incumbent water, when ſunk deep, before I truſted any perſon to deſcend much below the ſurface: and I never ſuffered any perſon to go under water, without having a ſtrong piece of rigging made faſt to it, until I found him well acquainted with the operations neceſſary for his ſafety. After that, I made him deſcend and continue at particular depths, without riſing or ſinking, row by the compaſs, approach a veſſel, go under her, and fix the *wood-ſcrew* mentioned in No. 2, and marked A, into her bottom, &c. until I thought him ſufficiently expert to put my deſign into execution.

I found, agreeably to my expectations, that it required many trials to make a perſon of common ingenuity, a ſkilful operator: the firſt I employed, was very ingenious, and made himſelf maſter of the buſineſs, but was taken ſick in the campaign of 1776, at New-York, before he had an opportunity to make uſe of his ſkill, and never recovered his health ſufficiently, afterwards.

Experiments

Experiments made with a ſub-marine veſſel.

After various attempts to find an operator to my wiſh, I ſent one who appeared more expert than the reſt, from New-York, to a 50 gun ſhip lying not far from Governor's Iſland. He went under the ſhip, and attempted to fix the wooden ſcrew into her bottom, but ſtruck, as he ſuppoſes, a bar of iron, which paſſes from the rudder hinge, and is ſpiked under the ſhip's quarter. Had he moved a few inches, which he might have done, without rowing, I have no doubt but he would have found wood where he might have fixed the ſcrew; or if the ſhip were ſheathed with copper, he might eaſily have pierced it: but not being well ſkilled in the management of the veſſel, in attempting to move to another place, he loſt the ſhip; after ſeeking her in vain, for ſome time, he rowed ſome diſtance, and roſe to the ſurface of the water, but found day light had advanced ſo far, that he durſt not renew the attempt. He ſays that he could eaſily have faſtened the magazine under the item of the ſhip, above water, as he rowed up to the ſtern, and touched it before he deſcended. Had he faſtened it there, the exploſion of one hundred and fifty pounds of powder, (the quantity contained in the magazine), muſt have been fatal to the ſhip. In his return from the ſhip to New-York, he paſſed near Governor's Iſland, and thought he was diſcovered by the enemy, on the iſland; being in haſte to avoid the danger he feared, he caſt off the magazine, as he imagined it retarded him in the ſwell, which was very conſiderable. After the magazine had been caſt off one hour, the time the internal apparatus was ſet to run, it blew up with great violence.

Afterwards, there were two attempts made in Hudſon's river, above the city, but they effected nothing. One of them was by the aforementioned perſon. In going towards

wards the ſhip, he loſt ſight of her, and went a great diſtance beyond her: when he at length found her, the tide ran ſo ſtrong, that as he deſcended under water, for the ſhip's bottom—it ſwept him away. Soon after this, the enemy went up the river, and purſued the boat which had the ſub-marine veſſel on board—and ſunk it with their ſhot. Though I afterwards recovered the veſſel, I found it impoſſible, at that time, to proſecute the deſign any farther. I had been in a bad ſtate of health, from the beginning of my undertaking, and was now very unwell; the ſituation of public affairs was ſuch, that I deſpaired of obtaining the public attention, and the aſſiſtance neceſſary. I was unable to ſupport myſelf, and the perſons I muſt have employed, had I proceeded. Beſides, I found it abſolutely neceſſary, that the operators ſhould acquire more ſkill in the management of the veſſel, before I could expect ſucceſs; which would have taken up ſome time, and made no ſmall additional expenſe. I therefore gave over the purſuit for that time, and waited for a more favorable opportunity, which never arrived.

Other Experiments made with a deſign to fire Shipping.

In the year 1777, I made an attempt from a whale-boat, againſt the Cerberus frigate, then lying at anchor between Connecticut river and New-London, by drawing a machine againſt her ſide, by means of a line. The machine was loaded with powder, to be exploded by a gun-lock, which was to be unpinioned by an apparatus, to be turned by being brought along ſide of the frigate. This machine fell in with a ſchooner at anchor, aſtern of the frigate, and concealed from my ſight. By ſome means or other, it was fired, and demoliſhed the ſchooner and

and three men—and blew the only one left alive, overboard, who was taken up very much hurt.

After this, I fixed ſeveral kegs, under water, charged with powder, to explode upon touching any thing, as they floated along with the tide: I ſet them afloat in the Delaware, above the Engliſh ſhipping at Philadelphia, in December, 1777. I was unacquainted with the river, and obliged to depend upon a gentleman very imperfectly acquainted with that part of it, as I afterwards found. We went as near the ſhipping as he durſt venture; I believe the darkneſs of the night greatly deceived him, as it did me. We ſet them adrift, to fall with the ebb, upon the ſhipping. Had we been within ſixty rods, I believe they muſt have fallen in with them immediately, as I deſigned; but as I afterwards found, they were ſet adrift much too far diſtant, and did not arrive, until after being detained ſome time by froſt, they advanced in the day time, in a diſperſed ſituation, and under great diſadvantages. One of them blew up a boat, with ſeveral perſons in it, who imprudently handled it too freely, and thus gave the Britiſh that alarm, which brought on *the battle of the Kegs.*

The above Veſſel, Magazine, &c. were projected in the year 1771, but not completed, until the year 1775.

D. BUSHNELL.

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